

woodch *blackbird*, C.

woodum *pond*, K.

wothamashet Lloyd : *to run* ; woothyat *to walk*.

zathrook *husband* ; cf. anwoyding.

zeek *necklace*, K. ; abbr. from baasick (?)

zósoot K., zosweet *partridge*. Ptarmigan is added to the term ; but a ptarmigan (*Lagopus alba*) is not a partridge.

Beothuk Song preserved by Cormack :

Sugut if bafu buth

baonsheen oōsadōōōsh edabauseek.

As there is no f in this language, the copying or the phonetics of this song must be partially faulty.

The Comet of 1866 and the Meteors of November 14th. By Professor Daniel Kirkwood.

(Read before the American Philosophical Society, July 17, 1885.)

The probable recognition of several ancient returns of the first comet of 1866, together with the identification of an additional number of star-showers related historically to this comet as their source ; the further confirmation of the existence of three distinct meteoric clusters all moving in the orbit of Tempel's comet ; and the data thus afforded for studying the structure and history of this interesting part of the solar system, afford sufficient reason for the following rediscussion of the facts now known in regard to the origin and history of the November meteors.

Tempel's Comet of 1866.

On the 19th of December, 1865, a small comet was discovered by M. Tempel, of Marseilles. It was generally observed till the following February ; and, although an inconspicuous object, its relations to the earth and Uranus have given it an importance equaled by few comets recorded in history. Its orbit was computed by Dr. Oppolzer, of Vienna, who found the time of revolution to be 33.176 years. Later researches, however, give 33.28 years as the more probable period. The comet seemed much smaller in 1865-6 than at any previously observed return—a fact indicative of its gradual dissolution. Its apparent magnitude, however, at any apparition, would evidently depend on the time of the year at which it passed its perihelion. Comets are recorded in the years 1733, 1699, and 1399, corresponding to dates at which Tempel's comet was due ; but these returns are to be regarded as doubtful. In 1866 Professor H. A. Newton suggested that the comet of that year was a return of one discovered in China, August 26, 1336, and which passed its perihelion October

13th. This identity is now very generally admitted. The interval between the perihelion passages of 1366 and 1866 is 499.3 years ; or fifteen periods of 33.28 years. The comet of 1266 may have been a return of the same body ; the comet seen in China, September 29, 1133, was in all probability Tempel's ; the interval between the apparitions of 1133 and 1366 corresponding to seven periods of 33.28 years.

The comet seen in January, 868, both in China and Europe, has been regarded by Hind and others as an early appearance of Tempel's comet. "In 868," Mr. Hind remarks, "at the end of January, a comet was observed under the tail of Ursa Minor, which moved in seventeen days almost to the constellation Triangulum. In China it was seen in the first moon (February) with the same right ascension as stars in Aries and Musca. I find by calculation that when Tempel's comet arrives at perihelion at the end of March or early in April, it must follow this path in the heavens, being first situated at the end of January in the constellation Camelopardus, where, for want of conspicuous stars of reference, it might be said to be below the tail of Ursa Minor ; afterwards moving to Triangulum and Aries."* Neglecting the apparitions of 1133 and 1266 as perhaps more doubtful, the interval between 868 and 1366 is equal to fifteen periods of 33.24 years.

"Sometime between April and December, A. D. 69, a comet appeared."† The interval between this date and 868 is equal to twenty-four periods of 33.28 years. Seven periods of the same length take us back to B. C. 165 ; nine more, to B. C. 465 ; and two additional, to B. C. 531 ; at each of which epochs a comet is recorded. 465 B. C. is also the date at which the celebrated meteoric stone, called the "Mother of the Gods," was said to have fallen from the skies. The entire history includes 2396 years, or seventy two periods of 33.28 years.

The orbit of Tempel's comet approximately intersects that of the earth near perihelion and that of Uranus near aphelion. The discovery that it is intimately related to the meteors of November 14, and the fact that one of the minor clusters of these Leonids is soon to return, give interest to a new study of the recorded phenomena.

The Meteors of November 14th.

Professor H. A. Newton traced back the great showers of 1866 and 1833 to A. D. 902.‡ He showed that the period must be 180 days, 185 days, 355 days, 377 days, or 33.25 years, and even suggested the method of determining which of the five is the true period. This important problem was first solved, however, by Professor J. C. Adams, of England, who found the periodic time to be about 33.25 years.

The comet's perihelion passage occurred January 11, 1866. The meteoric shower derived from the principal group, A, was observed in Europe,

* Monthly Notices, Vol. xxxiii, p. 49.

† See Chambers' Catalogue, No. ii.

‡ Am. Journ. of Sci., May and July, 1864.

November 14, 1866, and the display was repeated with diminishing brilliancy in 1867, 1868, and 1869. The most dense part of the cluster passed the descending node of its orbit about November 13, 1833, and hence also early in 1867, or about a year after the comet passed the same point.

The conclusion that Tempel's comet and the great meteoric cluster of 1833 move in the same orbit, and that the latter was in fact derived from the former, was reached almost simultaneously by Peters, Leverrier, and Schiaparelli. In 1875 the present writer called attention to the fact that the dates of several meteoric showers given by Humboldt and Quetelet as belonging to the November stream, indicated the existence of a second cluster, B, moving in very nearly the same orbit. These, with the writer's observations in 1852, are as follows :

A. D. 288, 28 September, apparition in China.

855, } 21 October each year. For particulars, see Quetelet's *Physique du Globe*.

1787, "On the night between the 9th and 10th of November, many falling stars were observed at Mannheim by Hemmer."

1818, } 12 and 13 of November.

1820, } 12 November.

1822, } 12 November.

1823, } 12 and 13 November.

1852, 13 November. *Nature*, 3 June, 1875.

The best observed seem to have been those of 288 and 1787. The interval, 1499 years, is equal to forty-five periods of 33.31 years. Seventeen of these periods bring us to A. D. 855. One period from 1787.86 brings us to 1821, the middle of the series 1818-1823. Another period would give 1854 as the time for the next display, the beginning of which was seen by the writer in 1852, when seventy-five meteors were counted between two and three o'clock. The next shower from this cluster will be due about November 13-15, 1887; the display, perhaps, commencing in 1886, or even in 1885.

The third cluster, C, has been less observed and is probably less extensive as well as less dense. The dates at which the shower has been observed are as follows :

A. D. 585, October 23 (O. S.). Quetelet's Catalogue.

1582, November 7. Quetelet's Catalogue.

1813, November 8. *Cosmos*, iv, p. 582.

1846, } November 13. *Ib.*, p. 578.

1847, } November 13. Quetelet.

1849, } November 13. Quetelet.

1879, } November 14. Observatory, Dec., 1879, p. 248, and Jan., 1880, p. 274.

1880, } November 14. *Pop. Sci. Monthly*, Feb. 1881, p. 542.

The phenomenon of 1813 was the most brilliant of this series observed in recent times. The interval between 585 and 1813 is 1228 years, or thirty-seven periods of 33.19 years; and the whole series of phenomena are represented as follows:

From 585 to 1582 . . .	997 y = 30 periods of 33.23 years.
1582 to 1813 . . .	231 y = 7 " 33.00 "
1813 to 1847 . . .	33.19 = 1 period of 33.19 "
1847 to 1880 . . .	33.19 = 1 " 33.19 "

The observed shower of 1582 was probably near the close of the cluster's passage across the earth's orbit. Thirty times the mean period of 33.19 years gives the epoch 1581.56, and the remaining dates are then perfectly harmonized.

The respective periods of the comet and the three meteoric groups are as follows:

Tempel's comet	33.28 years.
Group A (Newton)	33.25 "
Group B	33.31 "
Group C	33.19 "

During the last five hundred years the period of Group A seems to have been rather more than 33.25 years. The meteoric display of 1366 was contemporaneous, or nearly so, with the apparition of the comet, and the complete separation of this cluster from the original mass may have then occurred. "The comet of 1866 was invisible to the naked eye; that of 1366, seen under similar circumstances, was a conspicuous object. The statement of the Chinese historian that 'it appeared nearly as large as a tow measure,' though somewhat indefinite, certainly justifies the conclusion that its magnitude has greatly diminished during the last 500 years."* Is the less apparent magnitude a consequence of separation at that epoch?

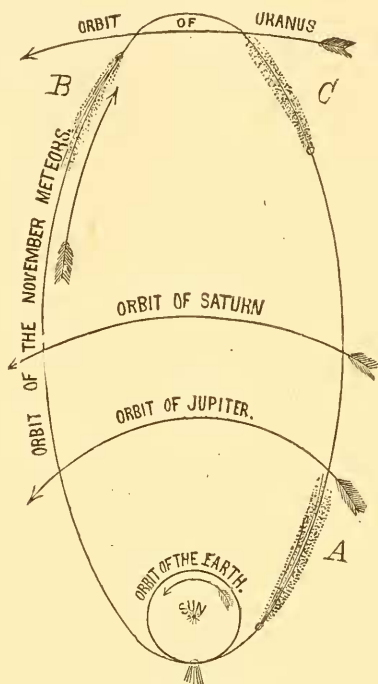
The following table affords the means of comparing the elements of the comet and those of the principal meteoric group:

	Nov. Meteors.	Tempel's Comet.
Perihelion passage	Nov. 10, 1866.	Jan. 11, 1866.
Longitude of perihelion	56° 26'	60° 28'
Long. of ascending node	231° 28'	231° 26'
Inclination	17° 44'	17° 18'
Perihelion distance	0.9878	0.9765
Eccentricity	0.9046	0.9054
Semi-major axis	10.3400	10.3240
Period	33.2500 y.	33.1760 y.
Motion	Retrograde.	Retrograde.
Computer	Schiaparelli.	Oppolzer.

The orbit of Tempel's comet and of the meteors associated with it is

* Comets and Meteors, p. 52.

represented in the following figure, where the relative positions of the meteoric clusters correspond to the epoch of the comet's perihelion passage in 1866 :



The next returns of these several bodies may be expected at the times indicated below :

Tempel's comet.....	1899
Group A.....	1899 to 1901
Group B.....	1886 to 1889
Group C.....	1912 to 1915

This cometary and meteoric orbit is a connecting link between the orbits of the earth and Uranus; the perihelion being immediately within the former, and the aphelion just exterior to the latter. All matter moving in it is liable to considerable perturbation by Uranus and the earth, but each of the meteoric clusters is now too extensive to be much disturbed as a whole. The present writer has elsewhere noticed that about 547 B.C., just before the first recorded (probable) appearance of Tempel's comet, this body and Uranus were comparatively near each other.*

* Comets and Meteors, p. 80.